

# Single Crystal Silicon Instrument Mirrors

## ---- Goals ----

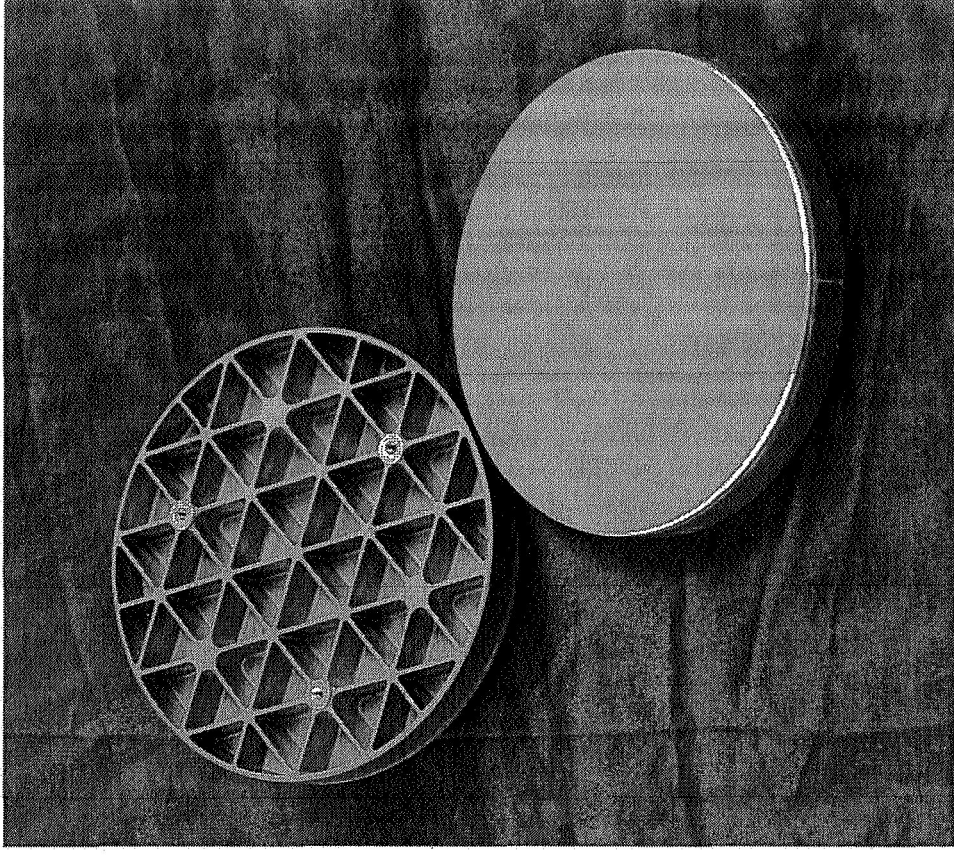
Develop a process for fabricating lightweight mirrors from single crystal silicon (SCS)

Modest lightweighting: 3X to 4X less than equivalent solid mirror

High surface quality, better than  $\lambda/40$  RMS @ 633nm

Significantly less expensive than current technology

Negligible distortion when cooled to cryogenic temperatures



# Single Crystal Silicon Instrument Mirrors

## -- Process --

Form single crystal silicon (SCS) blank

Grind and polish optical surface \*

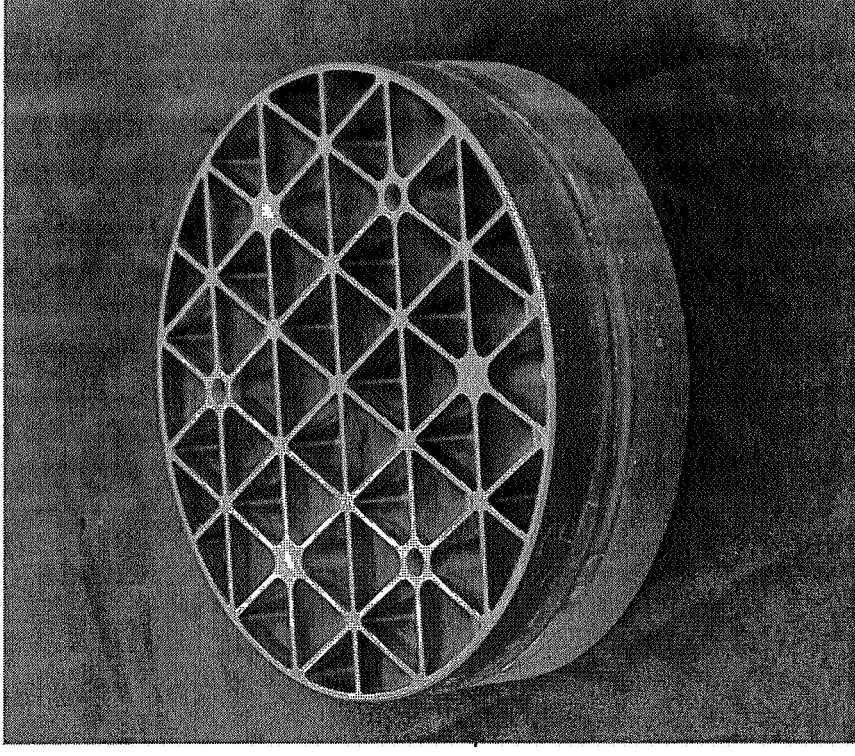
standard techniques and abrasives

Wax-on temporary Pyrex protector

Lightweight using ultrasonic machining

Post polish if necessary for extreme applications (better than  $\lambda/60$ )

*\* Solid blank without worry of print-through plus hardness/removal rate  $\approx$  fused quartz key to lower cost*



# Single Crystal Silicon Instrument Mirrors

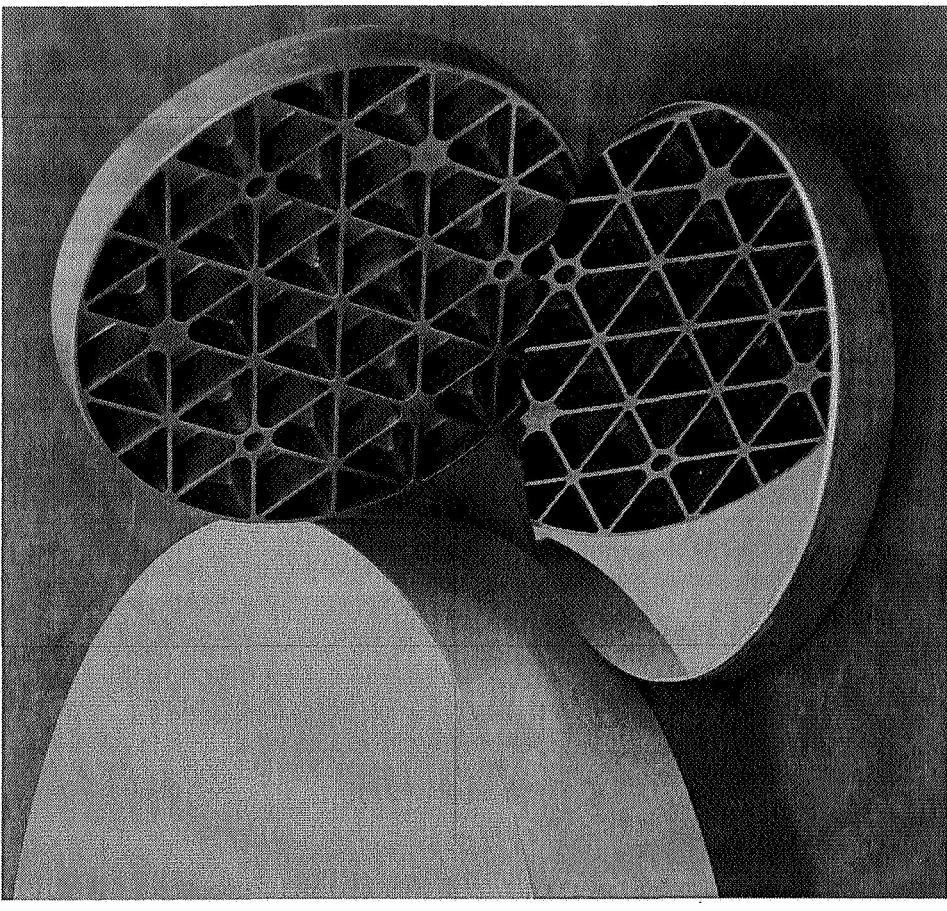
## -- Results --

11 SCS mirrors fabricated ranging in diameter from 10cm to 25cm

Lightweighting after polishing demonstrated to better than  $\lambda/50$

Post polishing demonstrated to  $\lambda/90$  without print -through

Test of cryogenic performance presently underway



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## Lightweighting Process

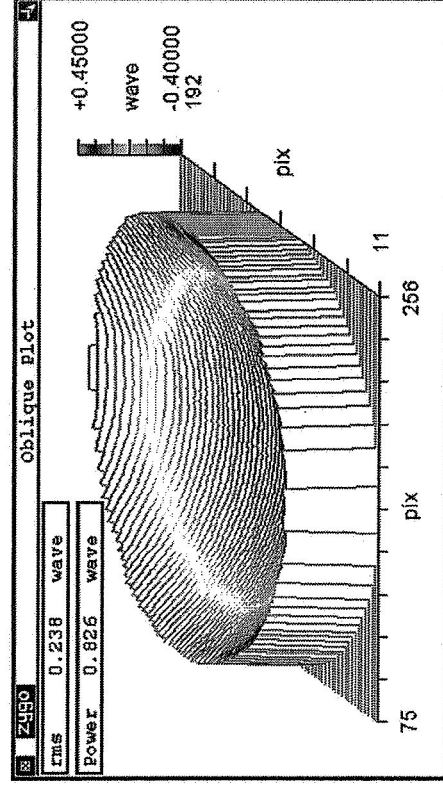
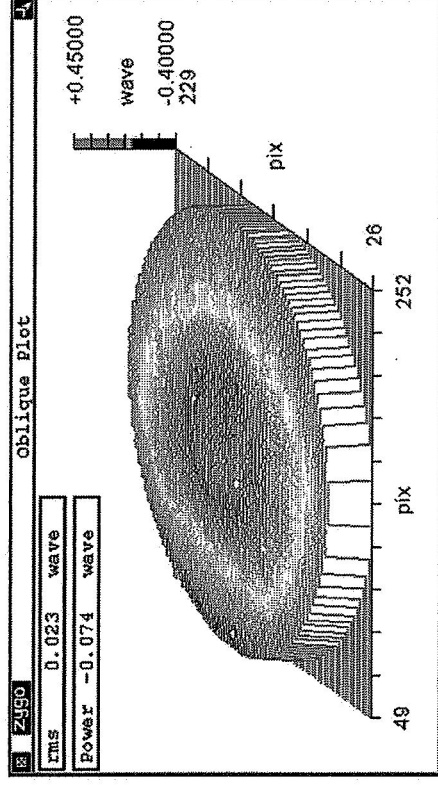


Figure before lightweighting

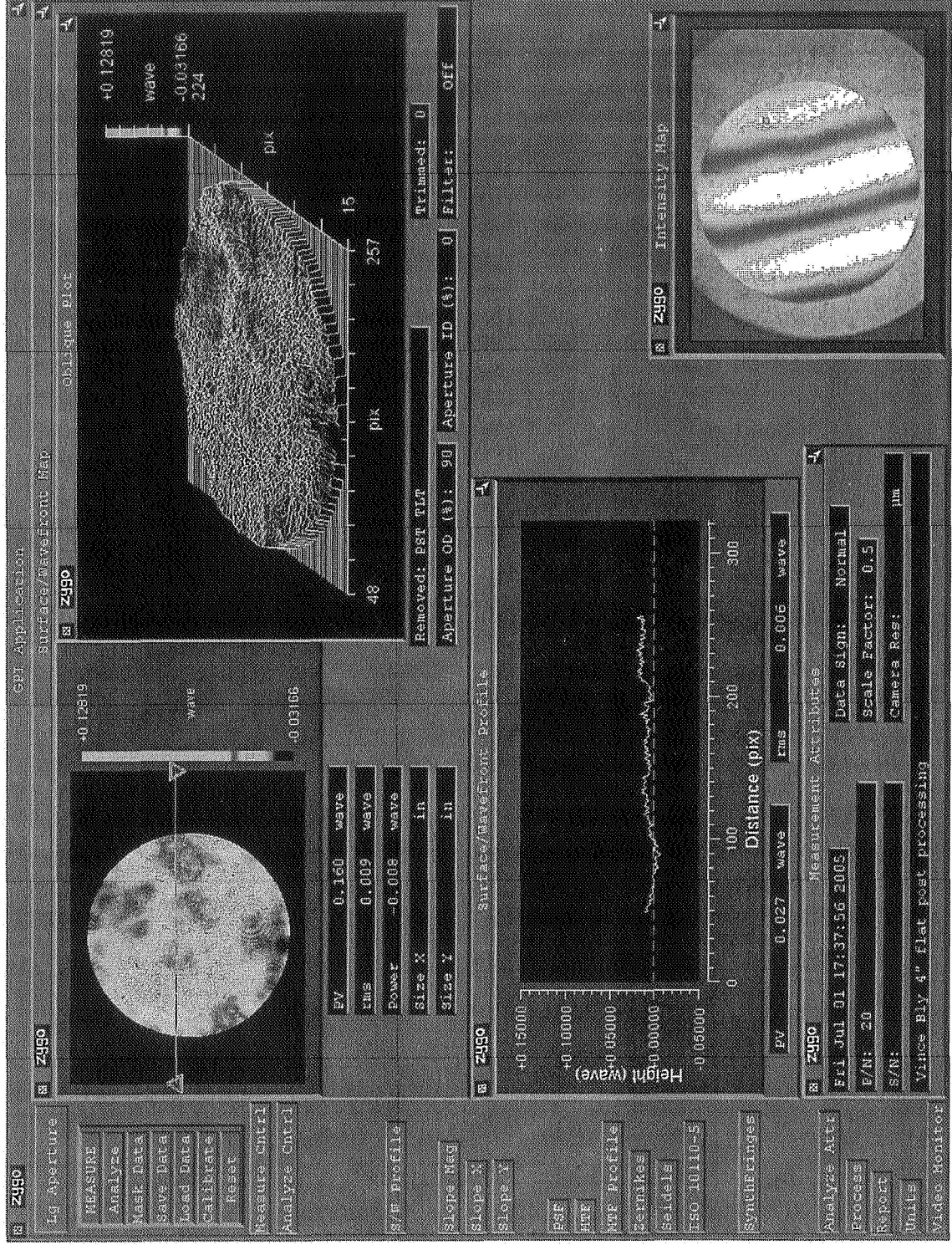
Figure after lightweighting,  
before heat treating

Figure after heat treating



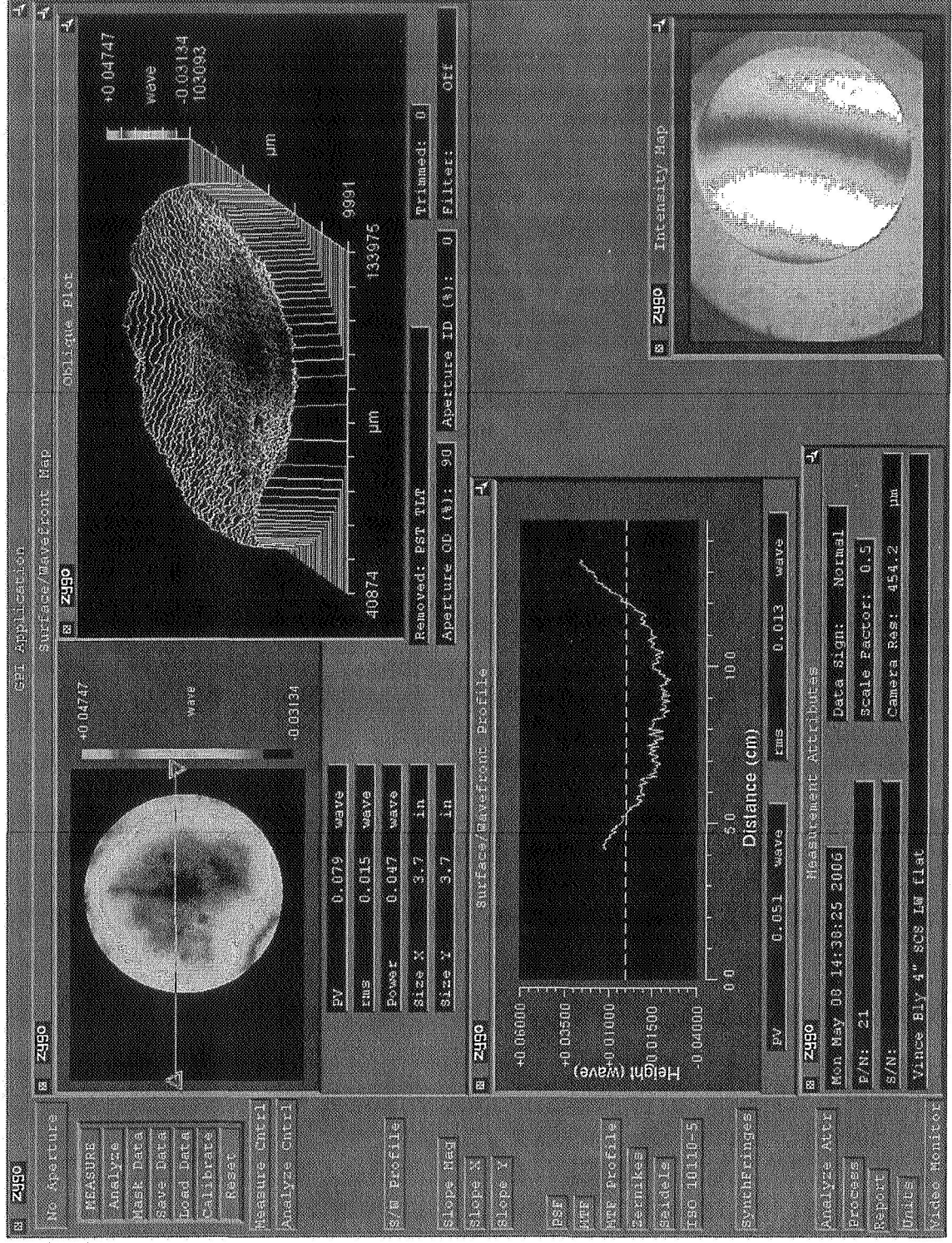
# Single Crystal Silicon Instrument Mirrors

## Interferogram of 10cm (4") SCS Flat #2C



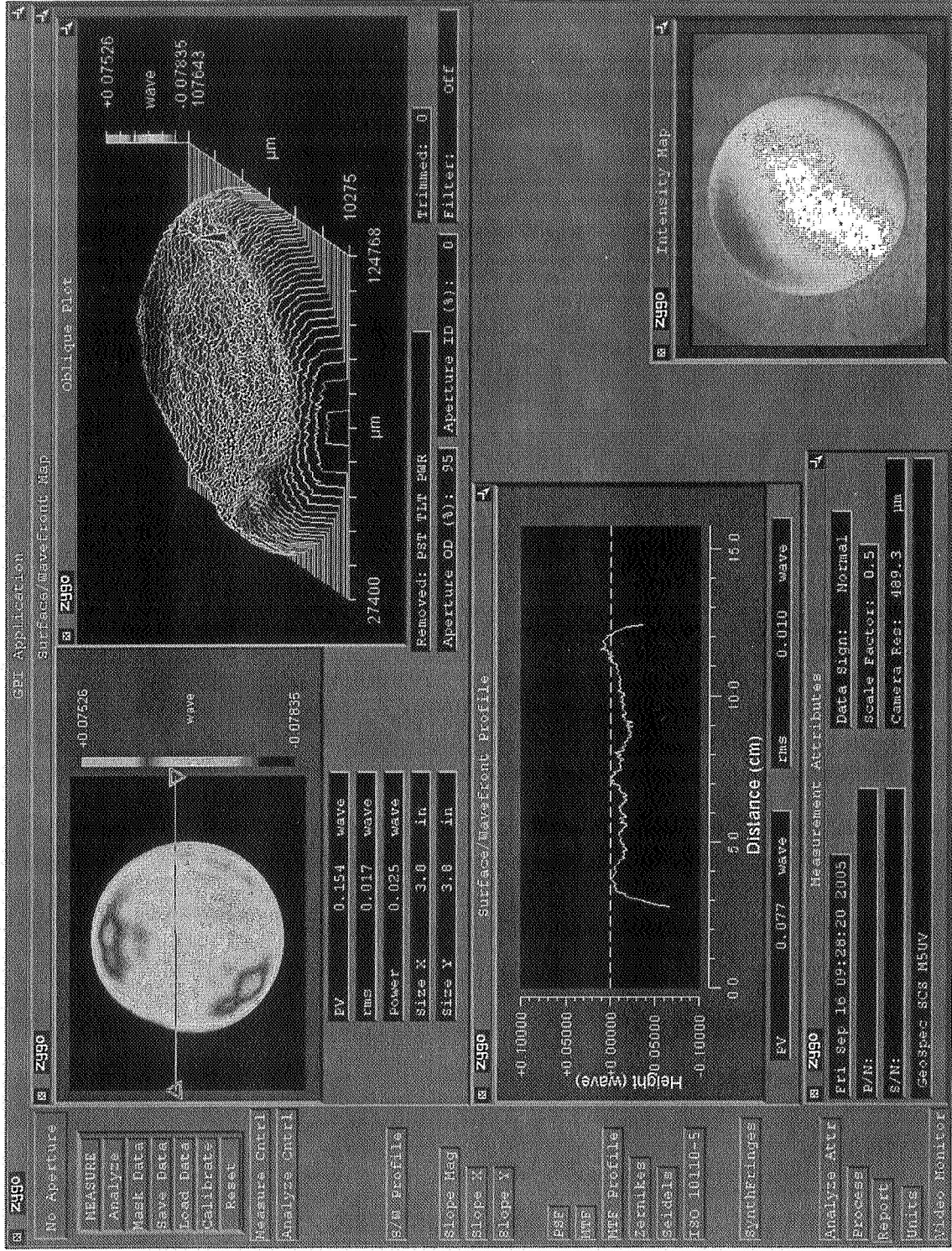
# Single Crystal Silicon Instrument Mirrors

## Interferogram of 10cm (4") SCS Flat #2D



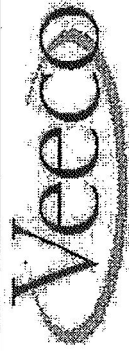


# Interferogram of F/1.2 Spherical Mirror for Geospec



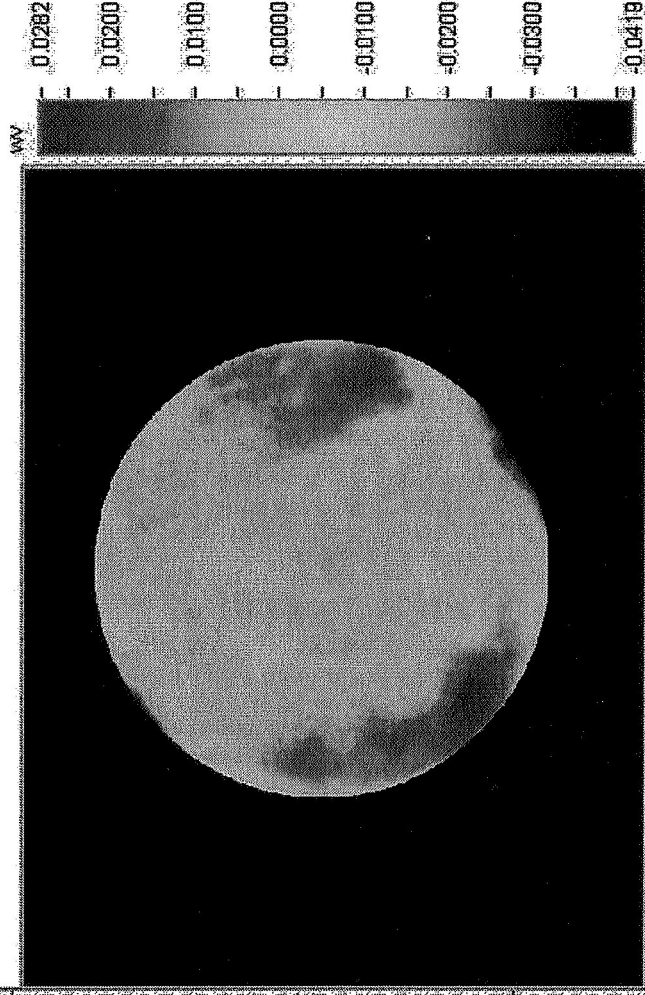
# Single Crystal Silicon Instrument Mirrors

## Interferogram of Early Mirror After Post Polishing



### Contour Plot

Measurement Parameters	
File:	21Nov02_vb
Wavelength	632.80 nm
Wedge	0.50
XYSize	736 X 480
Pixel size	0.00 um
Date	11/21/2002
Time	14:36:48
Averages	4
Analysis Results	
Ra	0.009 wv
Rms	0.011 wv
20 Pt. PV	0.067 wv
2 Pt. PV	0.07 wv
Analysis Parameters	
Terms	Tilt
Masks:	None
Filtering	No
Data Restore	
Valid Points	113443



Title: SCS Mirror 2A @90% aperture



# Single Crystal Silicon Instrument Mirrors

## -- Future Work --

Complete cryogenic testing and publish results

Demonstrate perforated primary

Demonstrate off-axis asphere using diamond turning or Zeeko process

Optimize lightweighting process for larger (>20cm) mirrors

